System Operation European Stakeholder Committee

Materials for meeting 14 June 2023

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Reliable Sustainable Connected

Agenda

Subject	Timing	Lead
1. Opening • Review of the agenda, approval of last meeting minutes • Review of actions	14.00 - 14.15	ACER, Uros Gabrijel ENTSO-E, Cherry Yuen
2. Update on the implementation actions at pan-EU level	14.15 - 14.30	ENTSO-E, Cherry Yuen
3. Update on Tmin FCR LER • LLEFD (Long-Lasting Extraordinary Frequency Deviation)	14.30 - 14.45	ENTSO-E, Luca Ortolano
4. Update on Winter 22/23 preparation • Operational coordination	14.45 - 15.00	ENTSO-E, Laurent Rosseel
5. Report on CGM Implementation	15.00 - 15.15	ENTSO-E, Habir Paré
6. Update on amendments proposals to KORRR methodology	15.15 – 15.30	ENTSO-E, Cherry Yuen
7. AOB • Implementation of Art.39 of SO GL – Follow-up of RoCoF discussion • Update on Wind Eclipse	15.30 – 15.45	All ENTSO-E ENTSO-E

1. Review of actions

ENTSO-E, Cherry Yuen

1 Review of actions SO ESC

ACTION	ANSWER	STATUS
CGM Implementation: ENTSO-E will provide an update on CGM use by RCCs in the next SO ESC meeting	Topic in agenda	Done
ICS Scale 2 Implementation: ENTSO-E will investigate if the Nordlink event is an ICS scale 2 and inform ACER as well	It is not an ICS scale 2 event See following complementary slide	Done
DFD: ENTSO-E will present the next update on DFD at the meeting either in June or September	Updates being prepared	Ongoing
ENTSO-E will investigate the question on blackout-proof requirements for aggregators in NC ER. ENTSO-E to provide update at SO ESC meeting 14.06	ENTSO-E NC ER Expert Team concluded that blackout-proof requirements for aggregators are not by default compulsory. See following complementary slide	Done

1 Rough event description for Nordlink 17th Feb 2023

2023.xx.1 - TO: On 300 kV-AC Sauda-Havik an L2-e fault (60ms) with successful AR (0,9 sec.) occurred.

2023.xx.2 - T1: NordLink 515kV kV-DC imported 1400MW to Norway. When previous fault occurred the Stacom
part of NordLink delivered full MVAr capacity towards the AC-fault to maintain voltage. The total MVAr and MW into
Norway exceeded the thermal overload limit and NordLink then reversed the active power to 300MW export to Germany (Wrong functionality).
The StatCom part of NordLink was supposed to shut down but did not (Would have been the correct functionality). The diff in MW between Nordic and CE was 1700 MW.
The functionality was corrected the day after.

2023.xx.3 - F0: The 1700 MW diff in the Nordic resulted in underfrequency reaching the first stem on the ICS-scale.

1.2 Answer on “blackout-proof aggregators”

Informal conclusion from the ENTSO-E NC ER Expert Team:

The Expert Team does not see a fundamental requirement for the integration of aggregators and dispatch centres in grid restoration. Rather, it is decisive whether these actors are assigned a role in the restoration process. This also depends significantly on the localisation of the aggregator/dispatch centre and the associated accessibility and connectivity in case of blackout. Based on these framework conditions, each responsible TSO evaluates the technical possibilities for a blackout-proof connection and the associated risks and challenges. As a result, this can lead to the exclusion and the renunciation of a blackout-proof connection of the aggregators/dispatch centres and therefore a direct communication between the TSO control centre and the power generation modules being implemented as the sole blackout-proof communication connection.

2. Update on the implementation actions at pan-EU level

ENTSO-E, Cherry Yuen

Pan-European or regional deliverables 2023: SOGL/NCER

CSAm (Article 44.5)	Secure data collection and validation platform being set up for the PRA (Probabilistic Risk Assessment) methodology expected in 2027 – annual TSO data collection process ongoing - Biennial report expected Q4 2023
KORRR amendments	First discussion took place with EU DSO Entity (topic in agenda) Revised version taking into account feedback received from stakeholders will be shared after conclusion
Operational Agreements	Ukraine/Moldova: Emergency Energy Supply MLA concluded Impact on Continental Europe Synchronous Area after synchronisation is closely monitored and reported regularly to ACER and NRAs

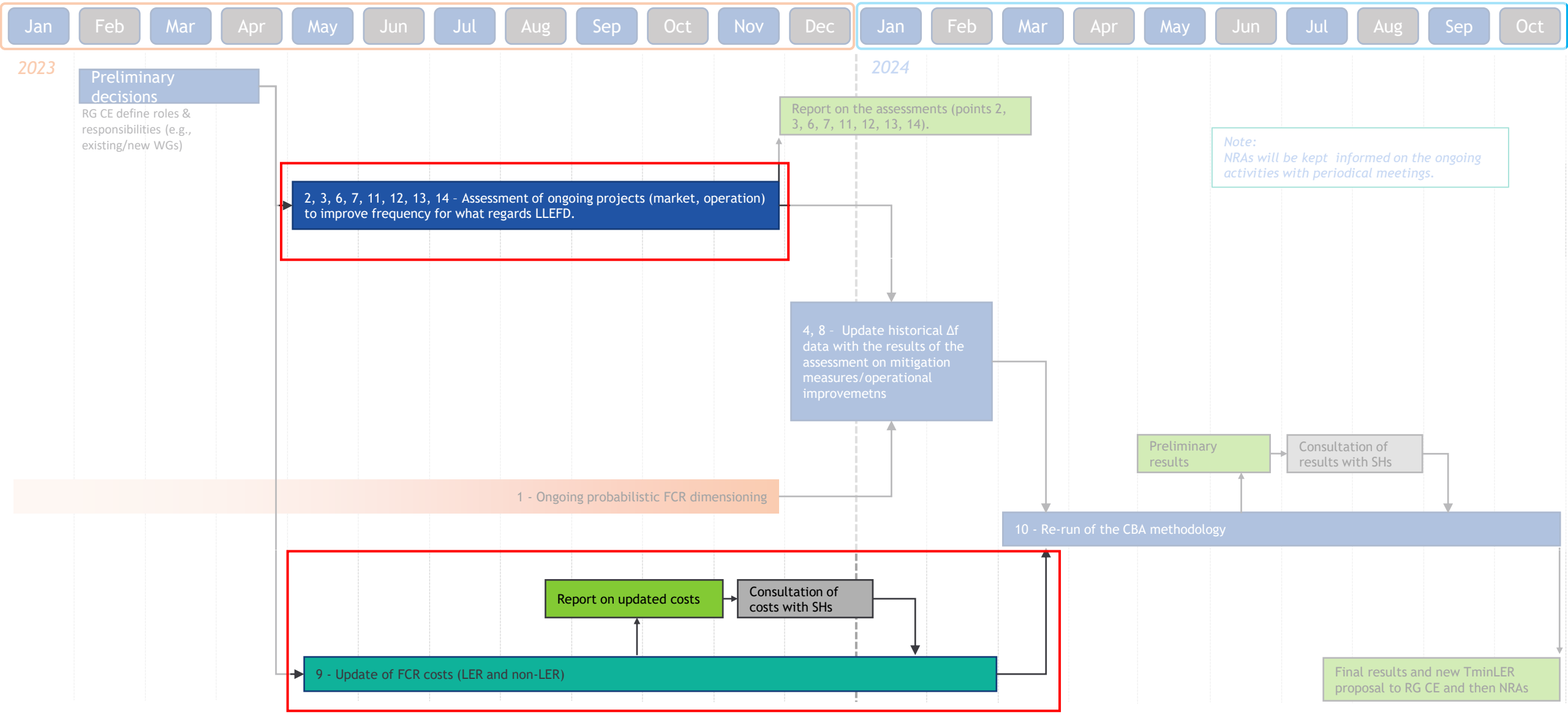
Pan-European or regional deliverables 2023: SOGL/NCER

SO GL (Article 153.2)	Methodology for performing the probabilistic dimensioning of FCR in CE SA Public consultation to close on 15th Jun 2023 – link
KORRR data exchange	(non-legal mandate) Follow-up on KORRR methodology on data exchange standards ENTSO-E joint-committee project launched (results expected end 2023)
CSAm amendments	Launch of public consultation https://consultations.entsoe.eu/entso-e-general/amendments-proposals-to-the-methodology-for-coordi/

3. Update on Tmin FCR LER

ENTSO-E, Luca Ortolano

Work progress on FCR by LER further analyses as requested by NRAs



Work progress on FCR by LER further analyses as requested by NRAs

- According to the agreed schedule, the results shall be consulted with stakeholders by November 2023.
- Considering the steps needed for the consultation to be approved (MC and RG CE plenary approval), the current **target deadline** is to have a preliminary draft by **mid-July**.
- The work is supported by the external consultant (CESI), which already supported ENTSO-E during the methodology definition.
- The work is ongoing with the following tasks:
  - *Updated assessment of FCR costs.*
  - *Updated sources and resulting for LER costs.*
  - *Updated sources and resulting for non-LER costs.*

Periodical update on the development will be held with the stakeholders.

Dedicated meeting with NRAs and ACER will be foreseen.

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Work progress on FCR by LER further analyses as requested by NRAs

- The overall task is aimed at performing an assessment of ongoing projects (market, operation) to improve frequency for what regards LLEFD.

- The **priority is on the further investigations about the most relevant LLEFD** occurred in the past.

- TSOs already performed an analyses of these events, with a focus on their root causes (involved Blocks, trigger, causes of underperforming reserve activation).

- NRAs asked a more detailed explanation on:
  - possibility of **cross-border reserve activation**;
  - **how** TSOs are going **to improve** their **operational procedures** to reduce/mitigate similar future events.

- The TF is elaborating on these tasks.

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Short list of activities from NRAs Request for Amendments and Concept note

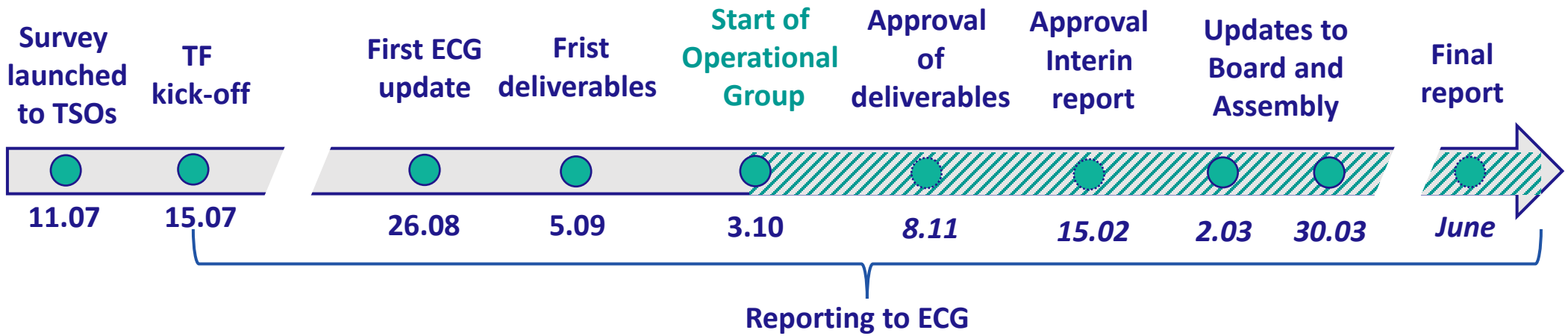
Short list of activities from NRAs Request for Amendments and Concept Note

- n. 2, 3 – Assess of the effectiveness of FRR/RR dimensioning and performances
- n. 6, 7 – List implemented/planned LLEFD and DFD mitigation actions
- n. 11, 12, 13, 14 – Assess performances mFRR/RR products for tertiary reserves needs and compare resulting performances
- n. 5 - Assess possible improvements in forecast quality
- n. 4, 8 – Simulate Δf, LLEFD considering all studied improvements
- n. 1 – Perform FCR Probabilistic Dimensioning
- n. 9, 10 - New survey to update FCR costs (LER and non-LER), run a new instance of the CBA

4. Update on Winter 22/23 preparation

ENTSO-E, Laurent Rosseel

Task Force's work - summary



Task Force For Operational Coordination for Winter 2022 - 2023

1. SURVEY AND EVALUATION
2. MONITORING AND REVIEW OF THE SEASONAL OUTLOOK
3. COUNTER-MEASURES
4. ASSESSMENT OF EXISTING PROCEDURES AND TRAINING
5. COMMUNI-CATION
6. FEEDBACK ANALYSIS

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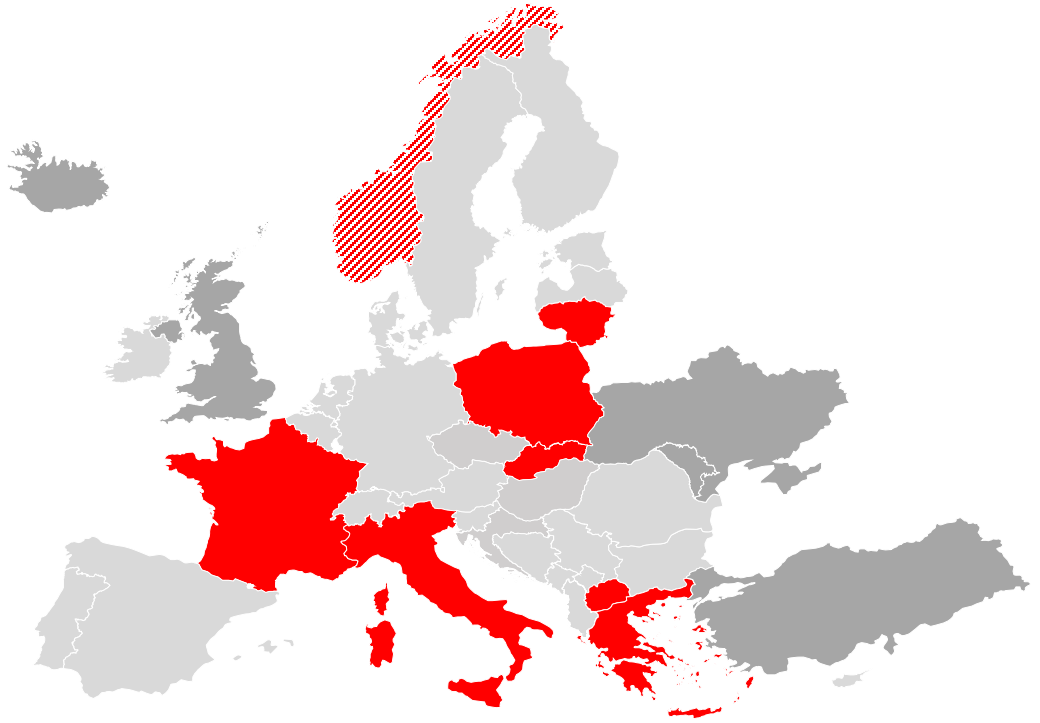
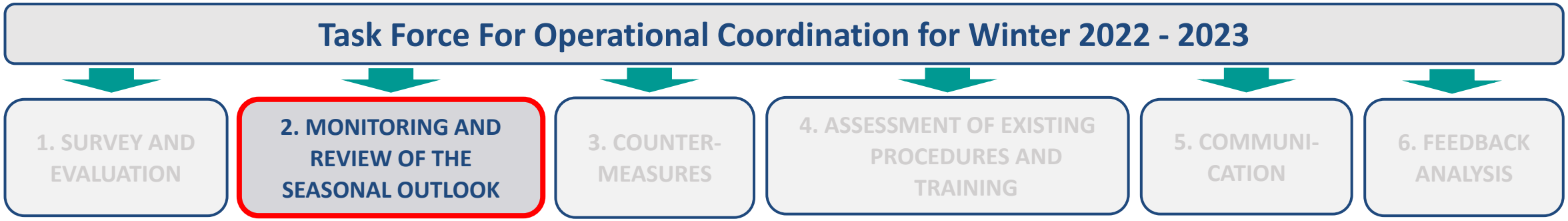
6. FEEDBACK ANALYSIS

- A survey has been conducted between 12th and 31st July among all ENTSO-E members
- The evaluated the risks and consequences of potential gas shortage in Europe, from point of view of system operations and winter outlook
- The survey results were analysed by the Task Force and indicated the way forward for Work Streams 2 - 5

Countries that reported the most significant operational impact



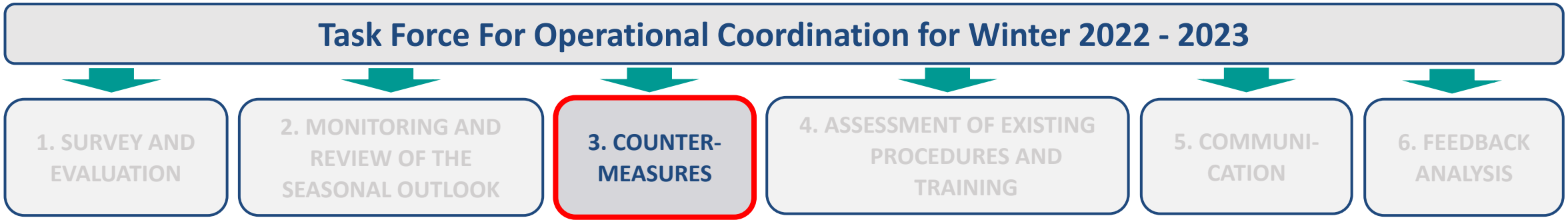


Objective

The objective of this Workstream was to propose recommendations to TSOs, RCCs and ENTSO-E Secretariat for a sustainable adequacy detection structure, for the importance of input quality and potential ways of improvement.

Deliverables

1. Recommendations on improvement of quality input data
2. Delivering a methodology for TSOs to apply conservative values
3. Monitoring of Seasonal Outlook (Winter Outlook) development
4. Recommendation in improvements for Short-Term Adequacy (STA) process



Objective

The objective of this Workstream was to provide an overview on available actions for TSOs to operate the power system at risk of load-shedding for any reasons. The goal was to raise awareness to TSOs for additional available measures to avoid load-shedding and to identify points for further discussion/alignment between TSOs (on bi- or multilateral level)

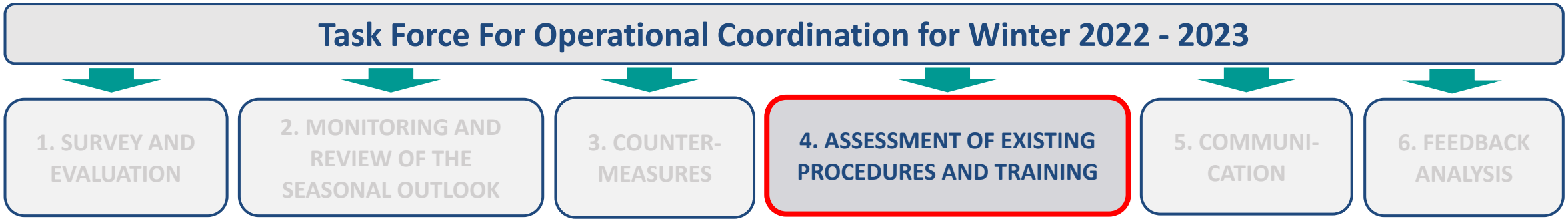
Deliverables

✓ 1. Analysis of existing countermeasures

✓ 2. Implementation of improvements in countermeasures (frequency deviations, short term OPS, D-3 capacity calculation, optimisation of energy flows)

3. Training on updated procedures and countermeasures (ongoing)

4. Recommendation on load-shedding affecting cross-border exchange (to be ready for next winter)



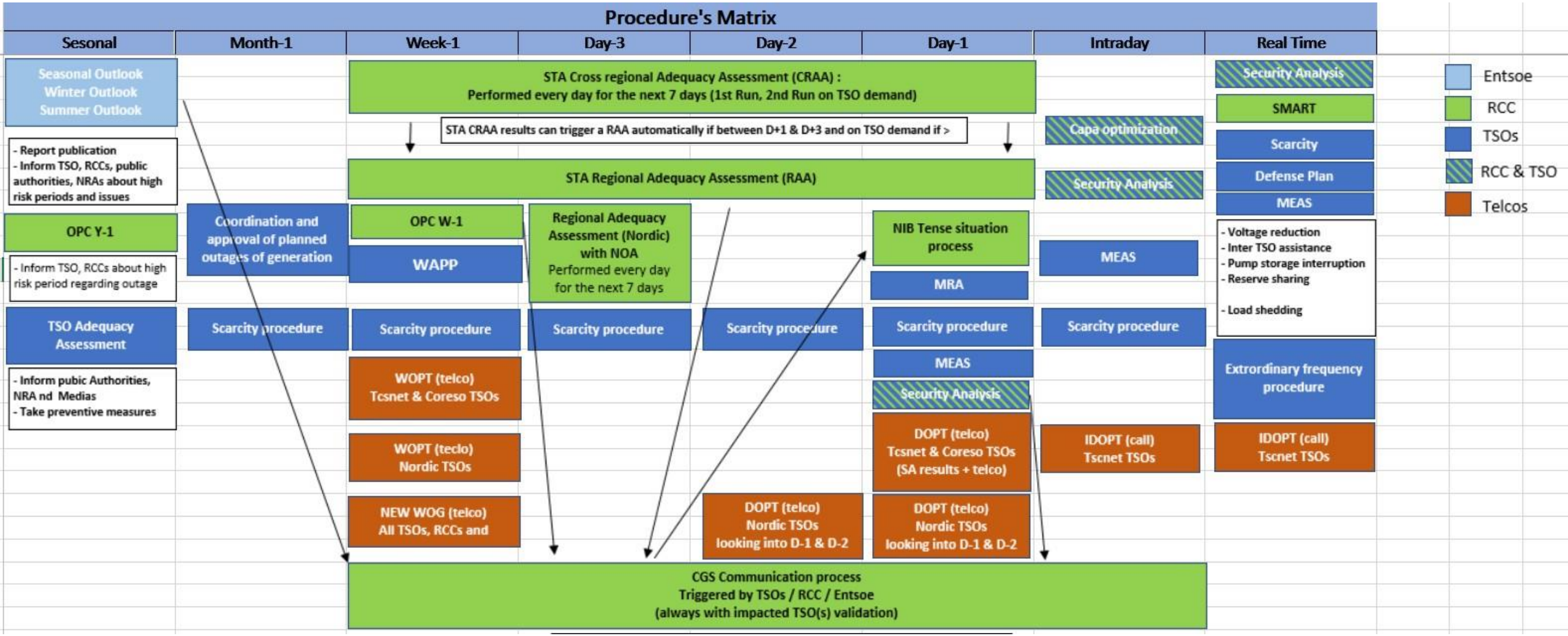
Objective

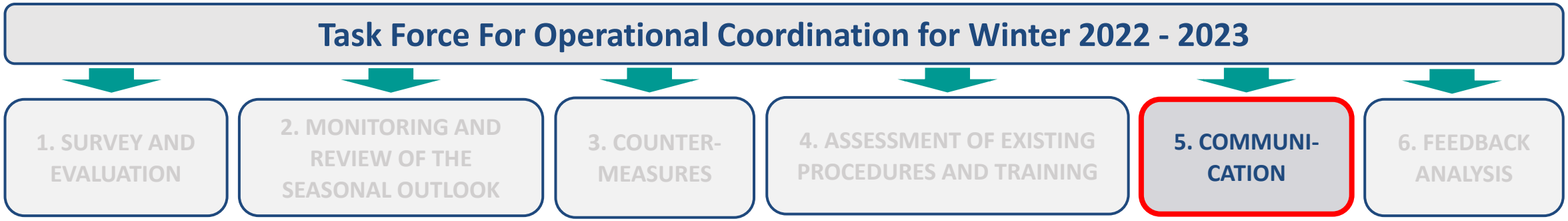
The objective of this Workstream was to ensure that TSOs, RCCs and ENTSO-E Secretariat are operationally ready in term of procedures, training and organization before the upcoming expected tense periods.

Deliverables

1. ✓ Survey on existing procedures
2. ✓ Recommendation to set up an internal action plan in each organisation
3. ✓ Testing and delivering recommendations to improve the Critical Grid Situation (CGS) Communication process
4. Facilitating STA trainings (ongoing)

Procedure matrix



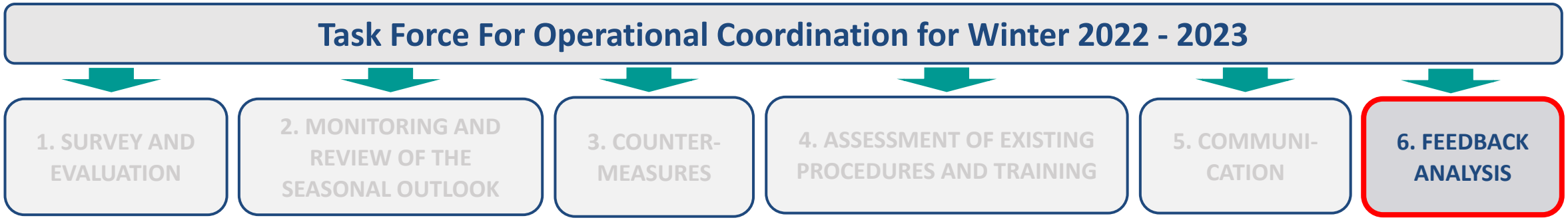


Objective

The objective of this Workstream was to identify the inter-TSO communication channels and to establish of procedure and responsible people in case of crisis. The workstream was responsible for coordination with ENTSOG representatives and preparation of communication towards media and general public.

Deliverables

1. Development of Crisis Communication Procedure
2. List of SPOCs of all TSOs and RCCs for purpose of Crisis Communication
3. Establishment of lines and channels of communication
4. Preparation of templates of messages \ reports to be used in case of crisis



Objective

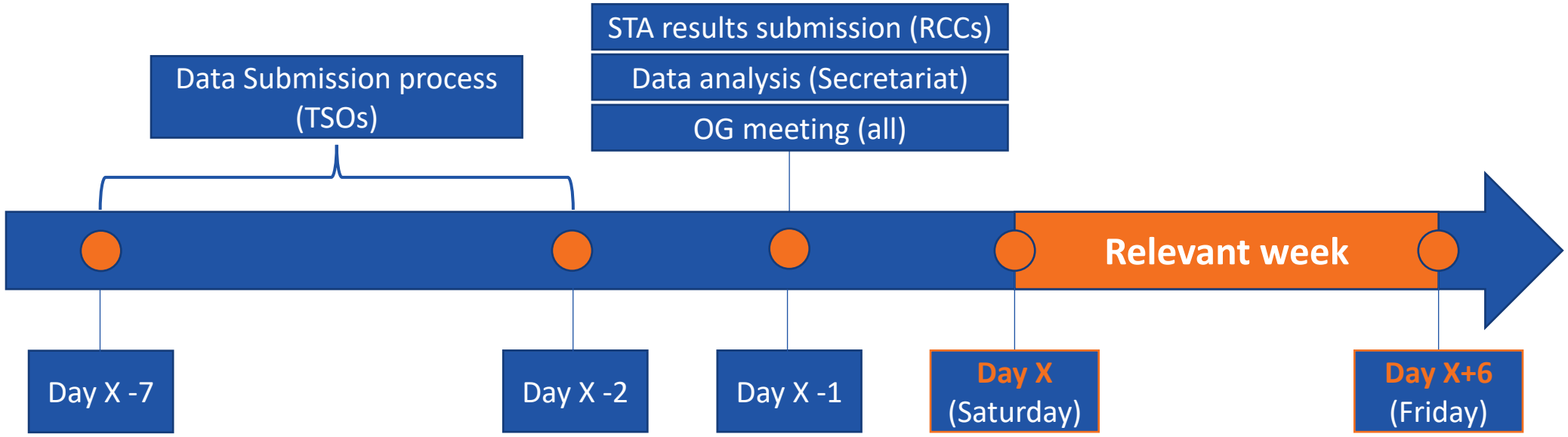
The objective of this Workstream is to deliver a report stating all the lessons learnt during the work of the Task Force for Operational Coordination for Winter 2022-2023. The work on the report will be initiated once all the deliverables are finalised.

Deliverables

1. ✓ Interim Report on lessons learnt
2. Final Report on lessons learnt (to be prepared by June)

Operational Group

- **All interconnected TSOs and all RCCs** participate in the group.
- All TSOs submit the data in **weekly cycle** (fuel supply, status of operating reserves, need for assistance, available DSR, unplanned outages impacting cross-border exchange, weather information, …).
- RCCs submit the results for **Short-Term Adequacy (STA) process**.
- The data is then analysed and used to prepare an overview of system's status for upcoming week.
- Operational Group meets weekly in order to align on the **forecast of system's situation.**



5. Report on CGM Implementation

ENTSO-E, Habir Paré

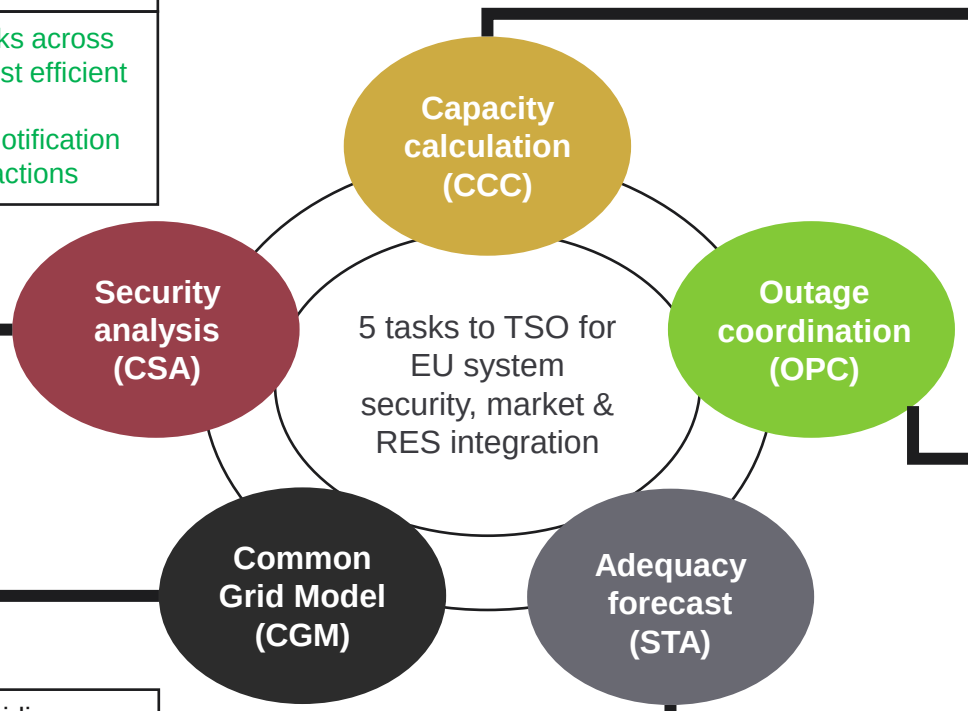
Why is regional coordination important?

Enabling reliable and efficient grid operations …

What: Identify risks to operational security in the vicinity of borders and identify efficient remedial actions as recommendations to affected TSOs

Benefits: Identification of operational security risks across all participating TSOs and identification of the most efficient remedial

- ***Risk identification***: operational security risk notification
- ***Efficiency***: identification of efficient remedial actions



What: calculation of available electricity transfer capacity across borders (either flow-based or net transfer capacity methodologies)

Benefits: Consideration of full grid =>

- ***Accuracy*:** more accurate calculation of available cross-border capacity
- ***Efficiency*:** more efficient utilisation of available capacity
- ***Responsiveness***: greater responsiveness to system conditions

What: single register of planned outages for grid assets and coordinated collaboration with respect to implications and options for outages

Benefits: Systematic and coordinated approach to outages, enabling:

- ***Efficiency***: optimised maintenance of outages across borders
- ***Transparency***: identification of issues caused by incompatible outages

What: Consistent pan-European grid model, providing an hourly view of grid assets (generation, consumption, transmission)

Benefits: single, consistent grid model across all affected TSO jurisdictions – a critical input to accurate outcomes from the other RCC tasks

- ***Consistency***: consistent, single, transparent grid models

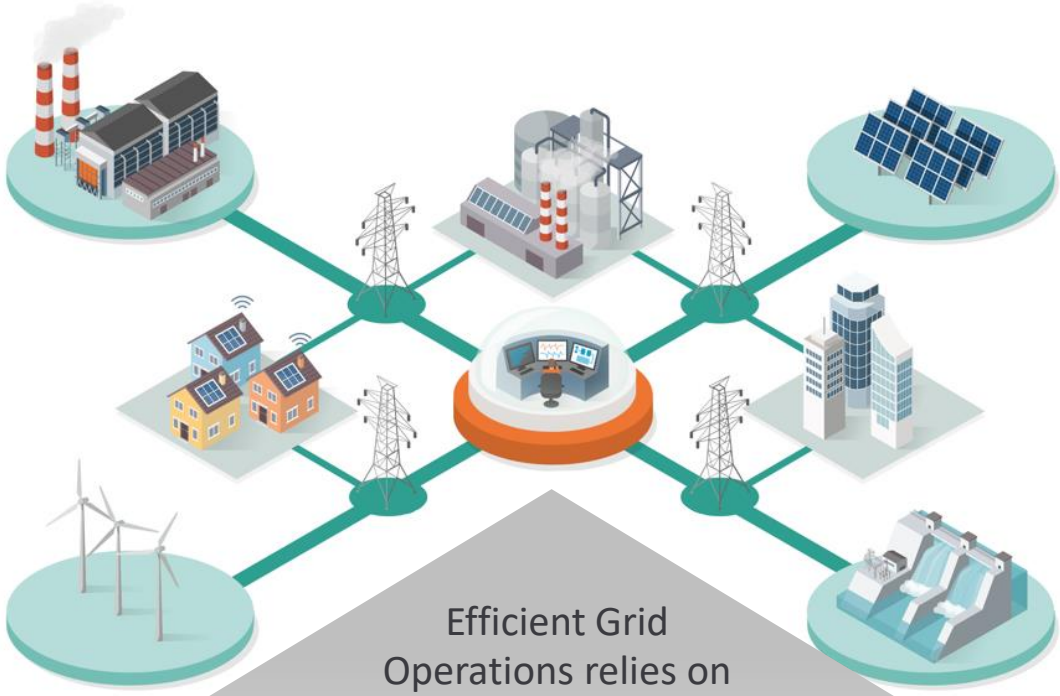
What: forecast adequacy and remedial actions

Benefits: pan-EU view of adequacy and available remedial actions:

- ***Early warning***: reducing risks of serious grid disruption
- ***Consistency***: single view of adequacy for TSOs, avoiding bilateral engagement with other TSOs

Importance of CGM & OPDE to facilitate these coordinated services

The **Common Grid Model (CGM)** and the **Operational Planning Data Environment (OPDE)** are fundamental enablers for reliable and efficient Grid Operations



Efficient Grid Operations relies on **Cross-Border Operational Planning**

Regional coordination processes

Coordinated Security Analysis	Coordinated Capacity Calculation	Outage Planning Coordination	Short and Medium Term Adequacy

ENABLED BY

Common/shared planning data

Common Grid Model (CGM)

SHARED AND ACCESSED THROUGH

Digital infrastructure for pan-European data exchange & storage

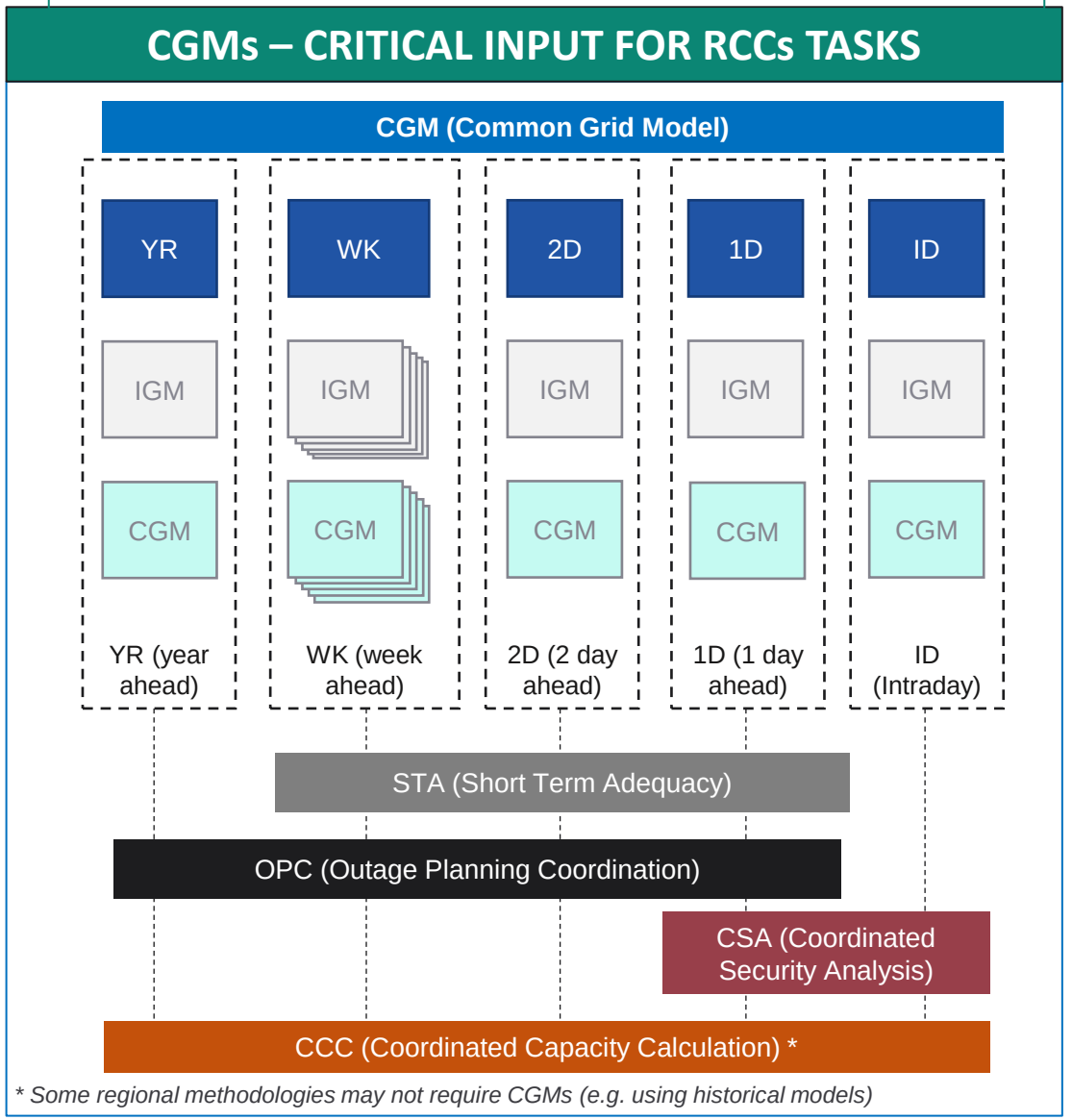
Operational Planning Data Environment (OPDE)

CGMs are a critical input to other RCC tasks

- **CGM is live**, but the "minimum viable solution" delivered Dec 2021 is not yet sufficient for the RCC tasks that will use CGMs (in CGMES format)
- Each service is **dependent on a different subset of timeframes.**
- As a result, it will be important to match delivery timescales for RCC tasks using CGMs **with priorities for improving completeness and quality**.

- Roadmap for exploitation of CGM in regional and cross-regional processes **is a complex interconnected set of delivery programmes, requiring an ongoing focus from the TSOs/RCCs/CCRs community**.
- Estimated timelines for the delivery of the RCC tasks are **available in the External Regulatory Report** published in June and December
- **A coordinated planning activity for RCC tasks** that is identifying dependencies and aims to reduce uncertainties has been set up.
- CGM is an enabler for the RCC tasks and not the other way around.

4. Get a plan about the exploitation of the CGM in the regional processes



Meeting model quality requirements

What are we doing to support full participation?

Execute central interoperability testing
extract quality metrics and report on how the TSOs can enhance the quality of their IGMs

Continuous activity

Improve error reporting
Improvements to error and warning messages, to aid understanding and troubleshooting

Ongoing:
OPDE 7.0 and 7.1 releases

Stabilise CGMES standard
Stabilization of the current CGMES version, enabling greater focus on improving model quality

DONE

Regular operational review
Weekly operational calls with TSOs and RCCs and reporting to identify issues and areas of investigation early

Continuous activity

Regular issue debugging
Analysis of issues raised in the tickets in OPDE support and targeted ENTSO-E Secretariat support

Continuous activity

Develop offline validation tool
Provision of tool (aligned with OPDE) which enables TSOs to test updates to their models and understand the impact of proposed new rules

Share modelling experience
TSOs and RCC modelling group has been established to share experience, provide support and collectively drive up overall quality

Continuous activity

Conduct validation sensitivity analysis
Temporary reduction in validation stringency to achieve incremental quality improvements

Deprioritised for another option

Next steps / focus areas for 2023

FOCUS AREA	*ACTIONS*	*MILESTONES*
OPDE DELIVERY & USAGE	• **Achieve full OPDE access** for all stakeholders	**Q2 2024**
	• **Await regulatory resolution to allow TSO with legal issues to participate**	**[Asap]**
	• Deliver new OPDE functionalities which will simplify installation, configuration and operation for **all TSOs/RCCs**	**OPDE Releases: Q2 2023, Q4 2023**
	• Identify improvements to vendor support arrangements	**ongoing**
	• Identify improvement for TSO performance self-monitoring (IGM quality, inclusion of IGM into CGM)	
GRID MODELLING	• SOC decision taken on 15 February 2023: CGMES 2.4.15 will be maintained for now (enabling focus on existing CGM service)	**Q1 2023**
	• **Continuous review/improvement** of effectiveness of all-TSO-RCC modelling group and interoperability, to maximise increases in overall performance	**Q1-Q4 2023**
	• Sensitivity analysis leading to **reduction of validation stringency testing**	**Deprioritized compared to other approaches**
USE OF CGM IN OPERATIONAL PROCESSES	• Developing roadmap of use of CGM in CGMES format in RCCs tasks	**Done**

6. Update on amendments proposals to KORRR methodology

ENTSO-E, Cherry Yuen

Background

- ENTSO-E initiated an internal analysis about the consequential changes of the amendments of the Capacity Allocation and Congestion Management Guidelines (CACM GL) initiated by the EC on the System Operation Guidelines (SOGL);

- The main impact pertains to the planned reallocation of the Generation and Load Data Provision methodology (GLDPM) from CACM to SO GL which would affect SO GL data exchange framework including the Key Organisational Roles and Responsibilities Requirements (KORRR) methodology;

- To address inconsistencies and potential gaps, ENTSO-E prepared amendment proposals which it presented to SO ESC on September 2022. ACER and DSO Entity asked ENTSO-E to further exchange on bilateral basis before triggering a public consultation;

Proposed amendments to the KORRR Methodology

	Amendment number	Amendment proposal
1	Amendment 1 – General amendments	Title change for KORRR removing words “All TSOs’ proposal for the” and updating references of the Electricity Regulation and Electricity Directive to regulations and directives that are currently in force.
2	Amendment 2 – Whereas section	Additional provision in the “Whereas” section on individual devices to be used for sending a real-time data. The national framework applied by TSOs and DSOs should clarify the required accuracy of the real time data, may it be individual tele-measurement or individual device providing aggregated data.
3	Amendment 3 – Whereas section	Proposal to remove KORRR whereas recital number (2).
4	Amendment 4 – Art. 3, General Responsibilities	Proposed amendment to the Article 3 “General Responsibilities” to complement it by mirroring requirements to ensure data providers fulfil DSOs needs even in the case where TSO is the primary receiver of aggregated data.
5	Amendment 5 - Art. 10, Provisions of Real-Time Information	*Each TSO shall define the refresh rate for the real-time data exchanges in its control area.* ~~**It shall not be longer than 1 minute.**~~ *The refresh rate shall take into consideration the requirements associated to the different system services and operational security requirements for which data exchange is* ~~*required*~~ *needed and requested”*
6	Amendment 6 - Art. 12, Rights and responsibilities of DSOs	Include the provision of topological remedial actions, topological agreed measures and best forecast operational topological situation in Article 12 of KORRR.

Preliminary feedback on bilateral exchange with DSO Entity

General points

- Unclear sequence of changes KORRR vs. SO GL; ENTSO-E asked clarification to EC (pending feedback)

GLDPM (article 12)

- DSO Entity querying whether the underlying GLDPM activity requirements are applicable to DSOs in the absence of requirements for DSOs in CACM. There can be no data if there is no activity.
- TSOs are required by CACM to provide a list of data providing entities which can include DSOs; also, DSO data provision under GLDP requirements is key for TSOs observability purpose as stated in Coordinating Security Analysis methodology (CSAm)

Refresh rate (article 10)

- In principle it could be OK to relax the requirements by deleting the 1 min threshold for DSO Entity but would require DSOs to be associated with changing thresholds to account for the impact of smart meter data and to avoid the risk of inappropriate DSO costs
- ENTSO-E view: refresh rate is a key requirement in the context of balancing services which ultimately is and should remain a TSO responsibility

Backup

Proposed changes to System Operation Guideline (SO GL)

Not discussed with DSO Entity

	Amendment number	Amendment proposal
1	Amendment 1 – SO GL Art. 40(10), Organisation, roles, responsibilities, and quality of data exchange	Adding the following wording to the provision 10 of the Article 40: “and other DSOs as applicable” in order to include also DSOs that do not have a connection point with transmission network.
2	Amendment 2 – SO GL Art. 43, Structural data exchange	Including a new point in article 43.3 for the provision of operational monitoring limits for relevant grid elements. Also, including in Art. 43(5) the provision of the total aggregated generating capacity of the type A power generating modules per connection point, not only per primary energy source.
3	Amendment 3 – SO GL Art. 44, Real-time data exchange	Include in Art. 44(e) the provision of control settings of regulating equipment where relevant.
4	Amendment 4 – SO GL Art. 47, Real-time data exchange	Include in Art. 47 a new point 1(d) in order to cover the provision of the type of control mode of power generating modules.

7. AOB

Implementation of Art. 39 of SO GL- Follow up on RoCoF discussion

No need to define min. inertia in interconnected case (SO GL art. 39 requirements)

Additional work by ENTSO-E:

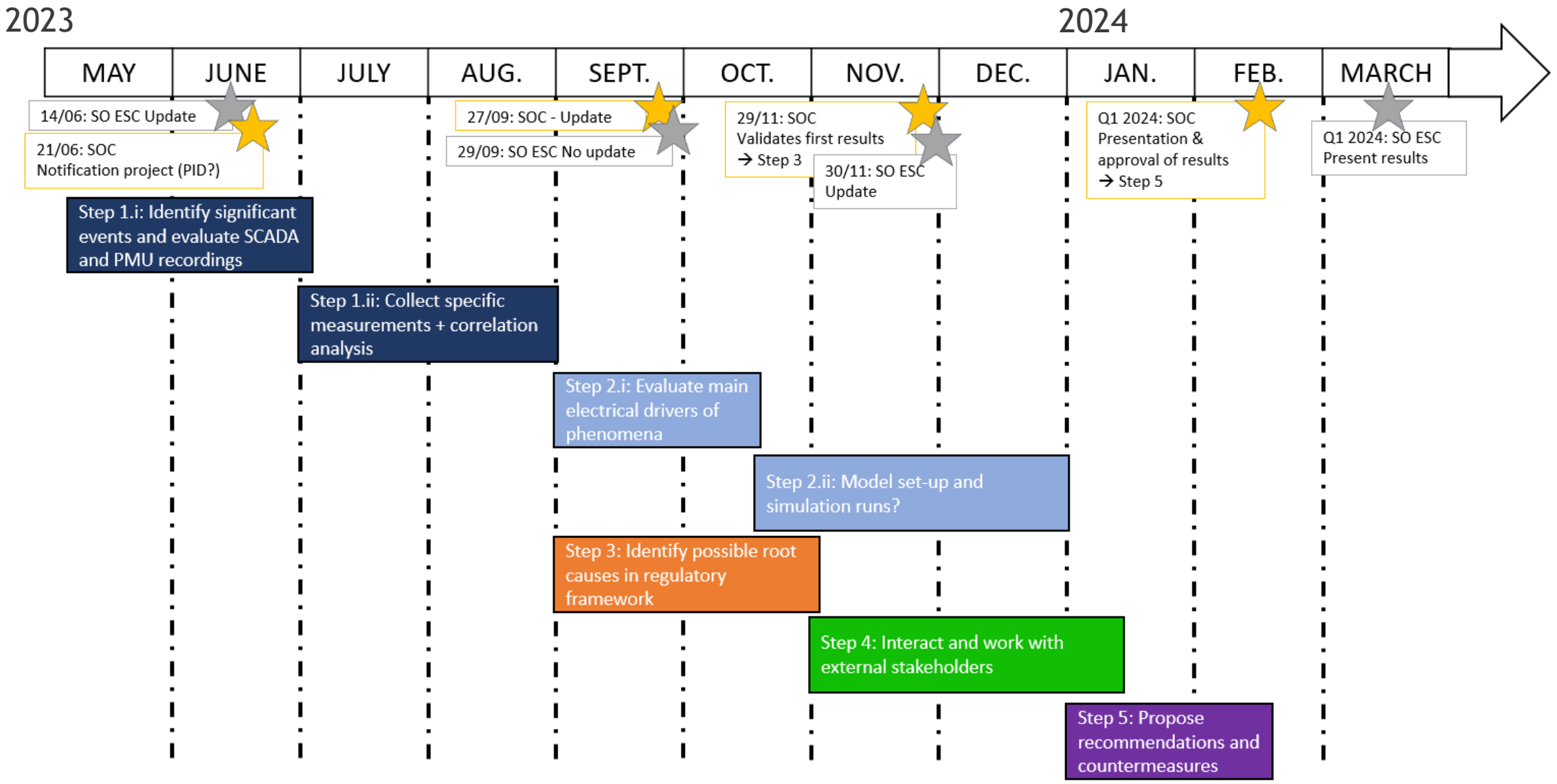
1) Inertia phase II (joint-committee project):

- update previous studies (the previous results (phase I) are confirmed with new scenarios)
- proposal on how to quantify min inertia for CE -> identify the scenarios to focus on, which splits, etc.
  - system resilience -> given the reduction of system resilience the idea is to counter this decrease and maintain an adequate level to cope with increasing challenges (RES integration, etc.)
- results ready for external discussions by end 2023 (expected)

2) Defence plan evaluation:

- next step after inertia project's outcomes are available -> which system splits, how much inertia for these events, etc.
- Identify additional measures such as load shedding, LFSM-O/-U, etc. which are needed besides a min. level of inertia to manage system splits
- timeline for final results -> end 2024 (expected)

Update on Wind Eclipse (project setup and timeline)



Presentation by EU Turbines – For information

EUTurbines – ROCOF Position

GC ESC 15 June 2023

Stakeholder supporting this presentation

RoCoF, where are we?

- Technology physical constrains for big units have been studied extensively by EUTurbines and discussed with ENTSO-E and other stakeholders in several meetings. The conclusions are recognized by all stakeholders.

- Based on these studies, EUTurbines concludes that a RoCoF local withstand capability of 1Hz/s during 500ms (maximal duration, not rolling window) could be an achievable requirement for these units, which is consistent with values indicated by ENTSO-E for system stability and already adopted in numerous countries (UK, Ireland, France,…); the finding are also in line with the conclusion of the KEMA-DNV report “RoCoF An independent analysis on the ability of Generators to ride through Rate of Change of Frequency values up to 2Hz/s”

- ENTSO-E provided a reference information for a grid and a table with different RoCoF values to be evaluated

- ACER organized a RoCoF dedicated meeting, occurred in Ljubljana on 10th of May 2023 where position of different stakeholders has been presented

- Expected follow up discussion with ENTSO-E and stakeholder in the coming weeks

What is ROCOF requirements?

- EUTurbines highlights that assessing the capability of real generating units to withstand without any damage and/or trip RoCoF values/profiles above 1Hz/s means not only electrical simulations, but involves
  - extended design engineering activities on multiple elements of complex units
  - A detailed understanding of the phenomena to be studied and correspondent simulation set-up (system frequency deviation, system splits, which can be totally different phenomena to be simulated)
  - Inertia threshold criteria might not be sufficient to assess capabilities, other parameters need to be evaluated

- RoCoF requirements are expected to be different for specific units and technologies and it should be the outcome of detailed investigation

- **This activity requires significant effort and it could be carried out only with extensive collaboration between manufacturers and system operators**

- It is difficult to estimate the risks and consequences of the frequency excursions and RoCoF values proposed by ENTSO-E.

EUTurbines notes on boundary conditions for ROCOF simulations provided by ENTSO-E

Example of preliminary analysis

Short circuit ratio: $S_{k\ (connection\ point)}''/P_{r(generator)}=6$
X/R ratio= 10
PSS: Off
Voltage: $U=U_r$
Operating point:
$P=P_{max}$,

- Q/P_{max}=0,33 (underexcited) **at the connection point** (with a realistic transformer).
- Q/P_{max} =0 (neutral) at the generator **at the connection point** (with a realistic transformer).

	Q/Pmax= 0%																
H	4Hz/s 250ms	4Hz/s 150ms	2Hz/s 250ms	2Hz/s 500ms	1,5Hz/s 250ms	1,5Hz/s 1s	1,5Hz/s 500ms	1,5Hz/s 250ms	1,25Hz/s 2s	1,25Hz/s 1s	1,25Hz/s 500ms	1,25Hz/s 250ms	1Hz/s 2s	1Hz/s 1,5s	1Hz/s 1s	1Hz/s 500ms	1Hz/s 250ms
8																	
7	NO			NO		NO			NO						OK		
6																	
5																	

Completed above are preliminary results of rotor angle stability studies for a typical 1800 MW nuclear shaftline.

(Reference: EUTurbines presentation of 30 January 2023 for ENTSOE Webinar on RoCoF amendment - SPGMs constraints).

EUTurbines position on ROCOF and Frequency Limits

EUTurbines position on ROCOF:

- **to use the 1Hz/s, 500ms value as target value,** as indicated by ENTSO-E upper limit for system stability and in line with DNV KEMA study
- **to not exceed present frequency limits,** new values as defined in the last proposal can have major impact on design and goes beyond existing technical standards and requirements.
- to define targets for RoCoF and frequency values that do not lead to risks of damage to generating units;
- To consider existing units to define appropriate RoCoF targets
- RoCoF requirement should also be used as target reference for defining local/global minimum grid inertia requirement

EUTurbines position on ROCOF and Frequency Limits

- **Assessing the real capabilities** to cope with the RoCoF and frequency limits values presented, represents a real challenge that is not easy to answer even in the future **for all grid users** and not only for the technologies represented by EUTurbines.

- EUTurbines considers that it is already a task of TSOs to define contermeasures to keep inertia and associated RoCoF in line with expected grid users capability and that various technical solutions are available to foster this accomplishment, like but not limited to:
  - synchronous condensers / fly wheels,
  - contribution from Grid Forming Converters (‘synthetic inertia’),
  - define RoCoF values compatible with existing units (likely ~1Hz/s for big synchronous units)

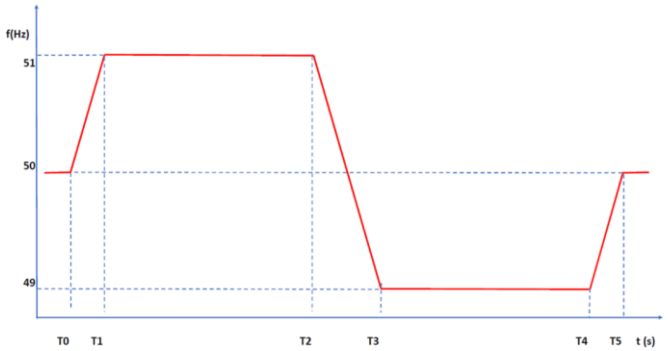
- This task is already indicated in the existing regulations (RfG (recital 25) and SOGL art 38 and art 39), and it is consistent with strategies already in place in countries adopting contermeasures to compensate for the erosion of grid inertia due to high RES penetration (eg Ireland and UK)

EUTurbines possible compromise

- A possible and reasonable compromise could be consider a RoCoF requirement of 1Hz/s, 500ms for all Type D units (no Pmax Threshold)

- EUTurbines could recommend for Type A, B and C to be evaluated among stakeholders and grid users the proposal/feasibility of adopting a requirement of 2Hz/s on 500ms (corresponding to 1Hz/s, 500ms global ROCOF):
  - This would be in line with ENTSO-E document (e.g. frequency stability in long-term scenarios and relevant requirements),
  - This would be in line with present requirements in most of European Countries,
  - This would be in line with CENELEC std EN 50549 -1 and -2,
  - This would not exceed the frequency limits threshold of 51.5 Hz Continental Europe and 52 Hz Uk.

RoCoF profile could be as described in EN 50549-10:



EUTurbines possible compromise for discussion

Type A, B and C SPGM and Type A, B, C and D PPM

2Hz/s, 500ms

Type D SPGM

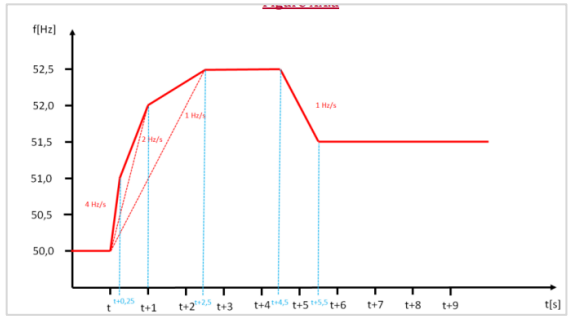
1Hz/s, 500ms

- Type C unit however has not been completely investigated (e.g. for generating unit in the range of 40 MW); the result of the investigation could be that in some grid conditions also such units can accept only up to 1Hz/s, 500ms ROCOF as proposed for Type D; in such a case appropriate wording shall be considered in the RfG 2.0 to cover such point.

On ACER back-up solution and RoCoF profile

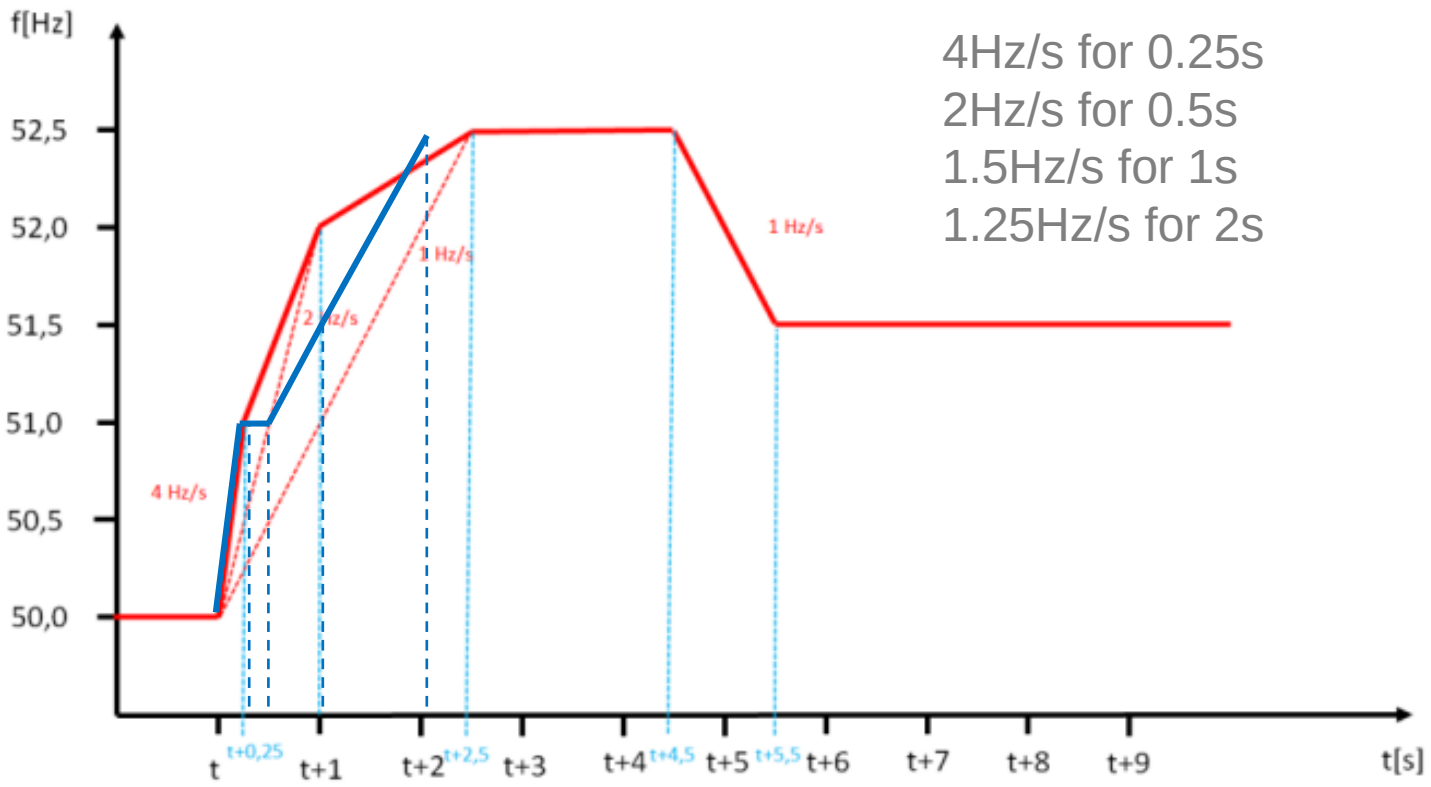
- During the 10th of May meeting ACER proposed a simplified solution
- We have issues with the proposed RoCoF requirements taken from ENTSO-E proposal
- We discovered during the meeting that the RoCoF values proposed are separate different requirements
  - 4Hz/s for 0.25s
  - 2Hz/s for 0.5s
  - 1.5Hz/s for 1s
  - 1.25Hz/s for 2s

Different/separate requirements from



- This was not as it was understood before when only the profile has been considered
- The above values (and the profiles) can lead to systematic misinterpretation **and need a revision**

EUTurbines comments on new profile



4Hz/s for 0.25s
2Hz/s for 0.5s
1.5Hz/s for 1s
1.25Hz/s for 2s

Real RoCoF on 500ms = 3Hz/s

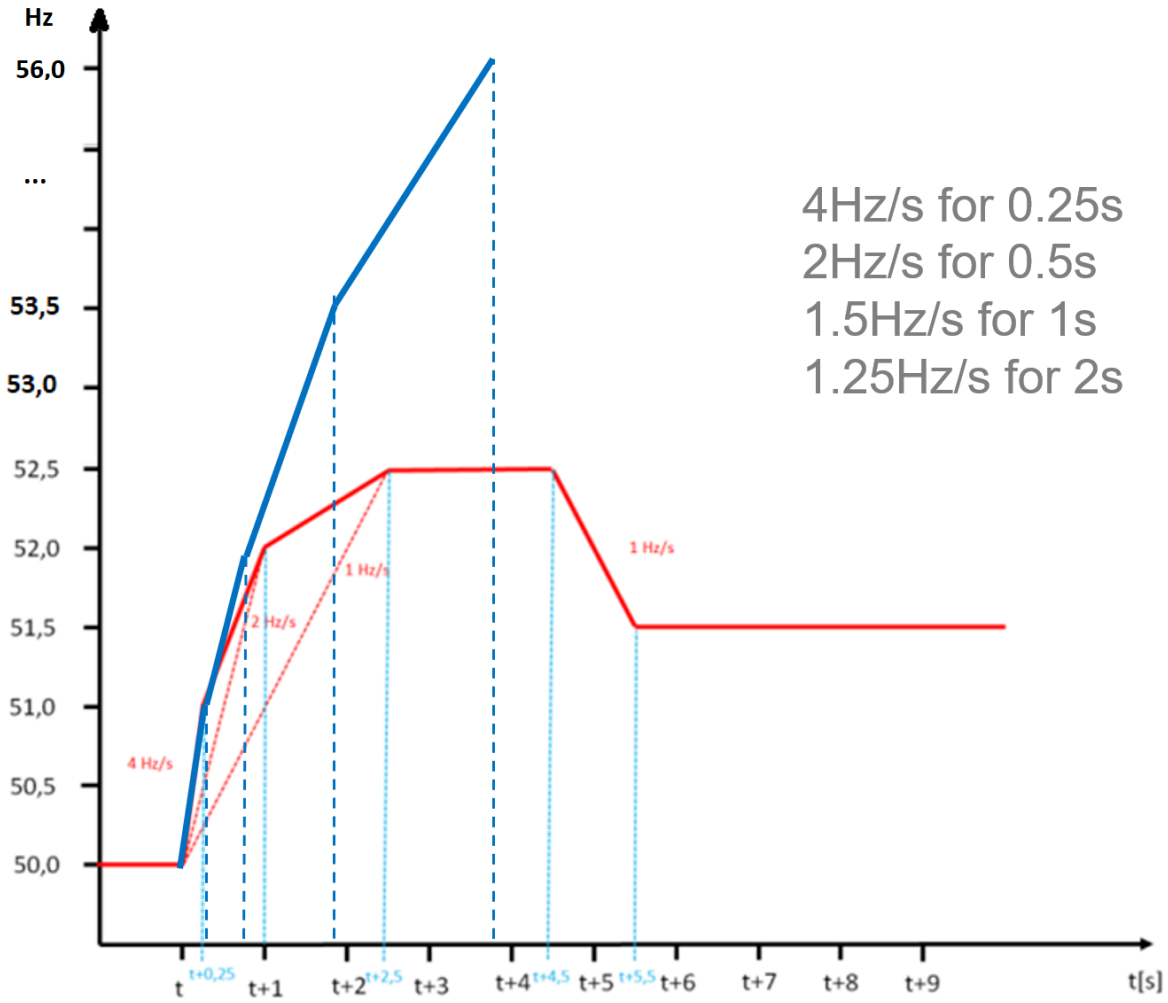
Beyond ENTSO-E stated system limits in case of grid splitting of 1Hz/s 500ms global RoCoF and 2-2,5 Hz/s local RoCoF on 500ms (*)

Beyond the ratio local/global RoCoF of 1.8 for 500ms as defined in presented studies German TSOs (**)

In general not in line with present National requirements and European standards

(*) FREQUENCY STABILITY IN LONG-TERM SCENARIOS AND RELEVANT REQUIREMENTS, 3 Dec 2021
(**) LoGlo Abschlusspresentation – Ruhr GmbH – 29.10.2021

EUTurbines comments on new profile



4Hz/s for 0.25s
2Hz/s for 0.5s
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(**) LoGlo Abschlusspresentation – Ruhr GmbH – 29.10.2021

Thank You!

Backup Slides / Inertia Constant H(s)

References for the definition of H constant from National Grid (UK) and IEC:

The maths behind inertia

$$H = \frac{½J\omega^2}{MVA}$$

H = Inertia constant in MWs / MVA
J = Moment of inertia in kgm² of the rotating mass
ω = nominal speed of rotation in rad/s
MVA = MVA rating of the machine

Typical H for a synchronous generator can range from 2 to 9 seconds (MWs/MVA)

$$\frac{\partial f}{\partial t} = \frac{\Delta P}{2H}$$

∂f/∂t = Rate of change of frequency
ΔP = MW of load or generation lost
2H = Two times the system inertia in MWs / MVA

nationalgrid
The power of action.

Abstract from IEC 60034-4 (2008) (replaced by IEC 60034-4-1 (2018)):

7.25 Valeur assignée des constantes de temps d'accélération et d'énergie cinétique réduite

7.25.1 A partir de l'essai d'oscillation du rotor suspendu

Les constantes de temps d'accélération et d'énergie cinétique réduite obtenues à partir de l'essai d'oscillation du rotor suspendu (voir 6.30) sont calculées en utilisant les formules suivantes:

$$\tau_J = \frac{J\omega_N^2}{P_N}\cdot 10^{-3} \quad ; \quad H = \frac{J\omega_N^2}{2S_N}\cdot 10^{-3}$$

avec les unités conventionnelles suivantes:

J	est le moment d'inertie, en kg·m²;
$\omega_N = \pi\, n_N/30$	est la vitesse angulaire assignée, en rad/s;
n_N	est la vitesse de rotation assignée, en tours par minute;
P_N, S_N	sont en kW ou kVA, respectivement.

Backup Slides / Gas turbine specific risks

Electrical Risks

- Loss of generator stability
- Power oscillations (initially Pmax & leading PF)
- Trip generator protections
- Impact on auxiliaries power supply
- Voltage oscillations due to interactions with PSS

Same risks as for large synchronous nuclear generators

Control Risks

- Combustion instability Loss of flame
- Compressor instability
- Load rejection to House Load
- Instrumentation “default”
- Reverse power (at Pmin)

Mechanical Integrity Risks

- Torsion fatigue
- Compressor/Turbine blade excitation

Same risks as for large synchronous nuclear generators

- Hot gas temperature out of tolerance

CONCLUSION OF THE STUDY FOR CCGTs:

High Rocof values may lead to hardware damage and further long period plant outage

Backup Slides / Ongoing simulations with New ENTSOE Boundary conditions / Preliminary results under review

			Typical 'big' EPR nuclear turbogenerator	Typical SMR 300MW range	Virtual SMR H=4s 300MW range
Total Turbogenerator Inertia Moment	**J**	**kg.m2**	**1205470**	**60000**	**28500**
Turbogenerator speed	**n**	**rpm**	**1500**	**3000**	**3000**
Total stored kinetic energy	**E**	**MWs**	**14857**	**2958**	**1405**
Turbogenerator apparent power	S	MVA	2094,1	350	350
Turbogenerator Inertia constant	**H**	**s**	**7,09**	**8,45**	**4,01**
Rotor angle stability with SCP=6*Pmax for the 2Hz/s IGD profile			**No**	**No (prel. results to be confirmed)**	**No (prel. results to be confirmed)**